A Resource Development Manual for Secondary Gas Recovery in Conventional-Permeability Sandstone Reservoirs

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Abstract

The Secondary Gas Recovery (SGR) Project, funded by the U.S. Department of Energy and the Gas Research Institute, addressed the recovery of incremental, or secondary, natural gas from existing, conventional-permeability fields. This additional resource in heterogeneous, or compartmentalized, reservoirs is commonly known as the reserve growth resource. From 1988-93, the project focused on the Tertiary of the onshore Gulf Coast of Texas and from 1993-95 the focus was on Pennsylvanian reservoirs of the Ft. Worth basin, Texas. Out of the extensive documentation of those phases of the SGR project, a project manual was developed. This manual serves as a guidebook that defines steps a producer can take to evaluate candidate reservoirs and potentially add reserves in depositionally complex reservoirs. While structural complexity and pervasive low permeability are acknowledged as also leading to reserve growth potential, the SGR project was primarily focused on facies complexity inherited from the original depositional system.

The approach taken in developing the manual was generic. It should be applicable to assessing heterogeneous gas reservoirs in many basinal settings after taking into account facies differences , subsidence rates, source-material differences, and other factors that define sedimentary environments. The producer is assumed to have basic knowledge of the depositional systems and facies associations composing the target reservoirs and on the generalized rates of subsidence and creation of accommodation space that affect facies geometries in the target basin. Background references on these topics are included in the manual. A key starting point for the SGR approach to natural gas reserve growth is the national atlas series of major gas reservoirs supported by the Gas research Institute and the U.S. Department of Energy.

The key element of the manual is a large-format (11.5x39 in) flow chart for the reservoir evaluation and development process called the "secondary gas recovery road map". This chart outlines the entire process of evaluating a property, down to the reservoir level, for its natural gas reserve growth potential on the basis of reservoir heterogeneity. The process outlines with in the chart comprises six major sections and serves as an outline and index for manual as a whole: characterizing reservoir heterogeneity, confirming the opportunity, analyzing depositional heterogeneity, defining the specific target, developing the

resource, and extending the opportunity. These six areas are then divided into 29 modules that comprise the 123-page manual. The manual focuses on integrated application of state-of-the-art geology, geophysics, reservoir engineering and well-log analysis needed to develop a reservoir for incremental natural gas resources.

The first step, characterizing reservoir heterogeneity, begins with accurate location and stratigraphic information to enter one of the gas atlases that cover major producing regions of the U.S. An applicable gas play is identified and using characteristics of that play, the producer makes an initial determination of styles of heterogeneity. Pervasive low-permeability, or heterogeneity that is largely structural, is presumed to be handled outside the SGR process. If the SGR approach is deemed applicable on a preliminary basis, then the next major step is to confirm the opportunity. This involves conducting a geologic and engineering screening to further confirm that the reservoir behaves heterogeneously. With this confirmation, the producer moves into a full analysis of depositional heterogeneity based on an initial flow unit concept of how the reservoir behaves. This is the critical step in the process since it is here that assessments are made to guide definition of specific resource targets. Included would be a geologic analysis, a pressure and production history analysis, a reservoir quality analysis, and a basic geophysical assessment, all depending on available data. The integration of these assessments leads to definition of the specific target and the strategy to test the prospect, i.e., a recompletion, new infill well, or horizontal lateral from an existing well. Developing the resource involves developing a data collection plan, recompleting or drilling the prospect, analyzing the data, and refining and further developing the concept of reserve growth applicable to this reservoir or play. With success, the producer will look to extend the opportunity, either within the initial play or elsewhere, and the process may begin again.

The manual is supported by six pages of references including many publications produced during the progress of the SGR project. Of particular note are a series of free technical summaries, short 9 to 15 page documents on engineering, geophysical and log-analysis topics applicable to natural gas reserve growth, that can be requested with purchase of the SGR manual. Also, 3-D seismic data sets for Stratton field (onshore South Texas) and Boonesville field (Ft. Worth basin, Texas) are available with supporting well logs, VSP, and other data at very modest cost. These data sets illustrate the applicability of 3-D seismic for detailed in-field reservoir development. The manual, seismic data, and other publications are available from the Bureau of Economic Geology, The University of Texas at Austin, (Publication Sales: 1-888-839-4365 toll free).